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NEWSLETTER

of the

Hawaiian Botanical Society

Volume III
Number 4
November 1964

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F U N G I I N H A W A I I

by Gladys E. Baker[1/]

The assemblage of organisms known as the fungi and popularly equated to the yeasts, molds, and mushrooms, represents a group little investigated in Hawaii. Fungi live as saprobes; in symbiotic relationship with other organisms; or as parasites on plants and animals including man. Their total number in the world has been estimated in the range of 200,000 species (Emmons, 1963). They are known from pole to pole in virtually every environmental situation: arid to wet areas; hot climates to cold; from sea level to the summits of mountain peaks; on dung as coprophilous species; in water whether fresh, marine or polluted, from the surface to depths of several thousand meters (Potter and Baker, 1960; Cooke, 1963; Roth, 1964); and from the surfaces of plants and animals (Ruinen, 1960, 1963; Potter and Baker, 1961). It seems unrealistic that this cosmopolitan group would not be well represented here. The lack of representation indicated by the paucity of literature on Hawaiian fungi is perhaps better explained by rarity of investigation rather than rarity of occurrence.

A few publications concerning Hawaiian fungi do exist. None is a comprehensive treatment for the total population in either a qualitative or quantitative sense. One paper (Stevens, 1925) is devoted to parastici fungi. Another (Burt, 1923) covers a limited group, the Hymenomycetes, and is based on limited material. A third paper is only a list and its reliability in part has been questioned. Other references are sporadic and often discuss a few, very specialized forms (Halde, 1953; Anastasiou, 1964). None of the investigations is concerned with marine or soil fungi. The soil is an important habitat for fungi and the ocean may be. A third habitat is that of the phyllosphere recently recognized as an important ecological milieu for tropical microorganisms (Ruinen, l.c.). None of these fungus habitats has been studied systematically in Hawaii. Any one of them, therefore, is a logical point of departure for a comprehensive survey.

It is now nearly 50 years since Selman A. Waksman posed his then startling, now classical, question, "Is there any fungus flora of the soil?" (Waksman, 1917). That fungi do occur in soil as natural inhabitants has long been accepted although aspects of their active roles continue to be elucidated. Fungi are important components of the microbial complex in the soil playing primary roles in the carbon and nitrogen cycles. Being "versatile opportunists" (Emmons, 1962) they perform many biochemical reactions ranging from the breakdown of complex compounds to the building of others. Many of these activities lend themselves to industrial exploitation. Before one can determine the role of fungi in a given habitat, the population present needs to be surveyed. Hawker et al (1960) called this the first phase of soil microbiology.

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In 1962 a survey of fungi in Hawaiian soils was begun with the collection of samples on Maui from sea level to the top of Mt. Haleakala, at approximately 10,000 feet elevation. Subsequently other collections have been made on Oahu, Kauai and Hawaii. The samples cover a diversity of conditions: rain forests; arid zones; beach areas; a salt pool at Kaena Point; steaming vents on the Chain of Craters road in Hawaii Volcanoes National Park; lava flows of different ages; and samples from the layers in three soil profiles dug by Dr. Dieter Mueller-Dombois in Kipuka Puaulu and Kipuka Ki of Hawaii Volcanoes National Park. A total of 103 samples has been subjected to-date to preliminary study of their fungus populations.

There are many methods for the isolation of fungi from a given sample. The quantitative plate dilution method is an accepted standard one although it is recognized that it has definite disadvantages. Any single method in itself imposes limits upon results but this method is valuable for comparative purposes. The use of sodium caseinate agar (Fred and Waksman, 1928) has proved its value over the years as one consistently yielding a maximum number of colonies of bacteria, Actinomycetes and fungi. Its low carbohydrate content coupled with the slow utilization of the casein encourages the growth of fungi as discrete colonies without objectionable overgrowth. Often fungi sporulate freely on this medium thereby facilitating their identification. Other media have been used in addition to sodium caseinate but none gives comparable quantitative results. Some media by the addition of antibiotics or other antagonistic substances, reduce the bacterial count. Others by the inclusion of growth factors encourage particular fungi. Two media especially useful for these reasons are Martin's rose bengal agar (1950) and Roth's medium (1964, l.c.). A valuable adjunct to the agar plate method is a modification of Warcup's method for the isolation of fungi (1950). The surface of an agar plate is flooded with a few ml of a low dilution of the sample (usually 2.5 ml of the 1:10 dilution). This is covered by a piece of sterile filter paper. In particular cellulose digesting species are found this way. Many species of Ascomycetes, members of the Acrasiales, Actinoplanes sp., and cellulolytic Fungi Imperfecti have been isolated by this means.

By such procedures an estimate of the numbers of fungi per gram of soil may be determined and the kinds identified. Numbers obtained may be too low to be satistically significant but all species isolated are significant for the qualitative analysis of the population. On a gravimetric basis there may be several hundred thousand fungi per gram of fertile soil (Hawker et al, 1960). Calculated on a live weight basis it has been estimated that an acre of such land would contain 500 pounds of fungus tissue (Alexander, 1961).

Quantitative counts for Hawaiian soils gave numbers from 1,000 to 860,000 per gram of soil. For all plates, including those not countable by statistical standards, the species per sample were enumerated and the number accruing from all samples totaled. The number of fungus species recovered from a given sample ranged from 1 to 39. In all, 235 species representing 125 genera have been isolated so far.

In an exhaustive study of 31 tropical soils from Panama and Costa Rica, Farrow (1954) used two basic methods and 17 kinds of agars making possible quite astronomical combinations. By these means he recovered 135 species representing 73 genera of fungi. Considering the fact that many of the Hawaiian sources of samples would not be expected to have high populations, it appears that Hawaiian soils are not lacking in fungi. Some characteristic figures (Table 1) for selected samples will serve to illustrate both quantitative and qualitative aspects of soil populations.

From these examples it is obvious that even the most barren areas (the top of Haleakala, cinder cones, the beaches, e.g.) are well endowed with residual fungi. Some of the isolates from the Haleakala sample (62.1) are coprophilous fungi, not astonishing actually

Table 1

Sample number	Source, characteristics	Number of fungi/gm	Number genera	Number species
62.1	Maui, 10,000', lava	Not countable	20	22
62.4	Maui, 3,000', grazed pasture	3,000	18	22
62.7	Maui, cane field	280,000	13	18
63.9	Hawaii, Kipuka Puaulu soil profile, 0-5 cm	1,000	3	3
63.15	Ibid, 30-50 cm, with abundant root systems	1,340	2	2
63.13	Ibid, 50-65 cm, organically enriched	22,000	2	2
63.16	Ibid, 70-90 cm, with roots	1,200	3	3
63.53	Hawaii, 1955 lava flow sedges and grass	24,000	3	3
63.54	Ibid, ferns established	50,000	5	5
63.55	Ibid, lichens	32,000	5	5
63.60	Hawaii, cinder cone	Not countable	3	3
63.24	Hawaii, Hawaii Volcanoes National Park, scenic drive, el. 5500'	Not countable	5	5
63.6	Oahu, Kaena Point, under Scaevola bush	5,000	8	12
63.7	Ibid, under Sesbania	10,000	10	12
63.58	Hawaii, Kalapana, Black Sand Beach	3,000	5	6
64.25	Kauai, windward shore at water line	Not countable	4	5
64.26	Ibid, above tide mark	4,200	5	8
64.27	Ibid, under Ipomoea	4,800	7	10
64.71	Kaena Point, salt pool	Not countable	3	3
62.11	Oahu, top of Mt. Kaala, rain forest	860,000	12	18

for many birds visit there. The figures from the Maui cane field (62.7) correspond to known high counts for fertile soils although the number of different individuals is not so great. From the soil profiles there is confirmation for the occurrence of the largest populations in organically rich situations. In this case the zone so determined by Dr. Mueller-Dombois (personal communication) was at the 50-65 cm depth. The high number per gram and low number of species represented means that the incident members sporulated well under the pertinent conditions. This illustrates one of the disadvantages of the dilution plate method as freely sporulating species may produce unrealistic counts.

The majority of fungi isolated represent species of the Fungi Imperfecti. Other groups were found less frequently. In summary the isolates included:

Group	Number of genera	Number of species
Acrasiales	3	3
Myxomycetes	1	1
Phycomycetes	8	12
Ascomycetes	11	19
Basidiomycetes	1	1
Fungi Imperfecti	101	199
Total	125	235

The low number of Basidiomycetes is not uncommon for this group rarely lends itself to plating methods for as yet unexplained reasons.

Many of the individual species are worthy of note. A coprophilous Ascomycete from the top of Haleakala is a species originally isolated from soil in Switzerland. A new species of the Fungi Imperfecti described very recently from Canadian soil (Barron, 1964), appeared in a Kauai shore sample at the water's edge and from the Kaena Point sample taken under a legume. Penicillium rotundum was described in 1948 from a wood sample taken in the mountains of Chiriqui Province, Panama. This species produces ascocarps and ascospores. It was isolated from a Maui sample at approximately 2000 feet. Curiously Farrow (l.c.) did not recover it among his isolates from Panama. Aspergillus unguis is a good example of an "opportunistic" fungus. It may be pathogenic to man but occurs occasionally in soil or in decaying organic matter. Our Hawaiian isolate came from one of the steaming vents of Aloi Crater Steam Flat, which had a temperature of 90°C (194°F), thereby handsomely extending its potential for opportunism. An apparently undescribed species of Tritirachium was isolated from sand on the windward side of Kauai. The same fungus has been isolated from the sea by Mrs. Carol Steele, a graduate student investigating fungi in marine habitats.

More unique isolates could be cited but their chief value is in pointing out the ubiquitous distribution of fungi in the world. It is their cosmopolitan distribution that makes it impossible to ascribe fungi to broad ecological zones (Hawker et al, l.c.). One reason for this possibly is the ease with which fungi travel. Many are well known as air borne. Currently another source of dispersal and distribution is recognized.

It is inadvertent but effective. From the analysis of 14 swabs of shoes taken from the soles of passengers prior to deplaning upon arrival in Hawaii or from soles of shoes in luggage and not yet worn here, 53 species of fungi representing 34 genera have been isolated this year. Of these 53 species, 10 were new listings for Hawaii. One fungus is a species described from Japan and apparently not known elsewhere. It was isolated from shoes which had been in Japan this past summer (courtesy Dr. C. H. Lamoureux). An isolate of Candida albicans, the major human pathogenic species of this genus, was also introduced this way. This pathogen though is already well established in Hawaii.

In summary, these preliminary studies representing random sampling of soils and shores of the Hawaiian Islands give an initial picture of a diversified fungus population present in a wide range of habitats in significant numbers. The techniques employed for the initial sampling now need to be extended to special methods for the isolation of particular groups of fungi. Then should follow the next phase of mycological investigation of the soil which Hawker et al (l.c.) describe as "the elucidation of the actual activities of such organisms when in the soil." It is safe to predict that these will be as diversified as their kinds.

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ORGANIZATION NOTES

NEW MEMBERS

Members elected June 1, 1964

Mr. Alex L. MacGregor
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Mr. N. Mohanakurmaran
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Mr. George A. Miura
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Members elected October 5, 1964

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Mr. Harrison E. Tenney
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Dr. Mahesh D. Upadhya
Dept. of Horticulture
University of Hawaii

Mr. Alan L. Young
908 University Avenue
Honolulu, Hawaii

DECEMBER MEETING: The December meeting will convene on Monday, December 7, at 7:30 PM in Agee Hall, H.S.P.A. Experiment Station, Keeaumoku Street. The program will be given by Dr. Sherwin Carlquist of the Claremont Graduate School and the Rancho Santa Ana Botanic Garden, Claremont, California. Dr. Carlquist will present an illustrated talk entitled "The Alpine Flora of New Guinea," based on his recent explorations in New Guinea and adjacent areas.

The November meeting was held on Monday evening, Nov. 2. The program was given by Professor G. Ledyard Stebbins of the University of California who spoke on "The Natural History of Polyploid Complexes."

The October meeting was held on Monday evening, October 5. The program was presented by Dr. Sam E. McFadden, Jr., ornamental horticulturist and visiting professor in Horticulture at the University of Hawaii. Dr. McFadden gave an excellent talk on the subject: "Roses in the Subtropics."

U N I V E R S I T Y O F H A W A I I

DEPARTMENT OF BOTANY: Mr. Henry O. Whittier, formerly Instructor in Botany at the University of Hawaii, is currently engaged in bryological field work in Tahiti. His work is supported by a grant from the Society of the Sigma Xi. He will return to the mainland in December, at which time he will move to the New York Botanical Garden where he will be employed while working for his Ph.D. at Columbia University.

Professor George Hollenberg of the University of Redlands has joined the staff of the Botany Department at the University of Hawaii as a replacement for Professor Maxwell S. Doty who is on sabbatical leave. Dr. Charles H. Lamoureux was recently promoted from Assistant Professor to Associate Professor.

Recent visitors to the Department of Botany include Dr. A. S. Sharp, University of Tennessee, Dr. G. Ledyard Stebbins, who presented a seminar on October 30, and Professor C. W. Wardlaw, University of Manchester, England, who gave a seminar on November 6. Earlier visitors included Dr. and Mrs. Ernst Abbe who stopped en route to Minneapolis from Malaysia, New Guinea and New Caledonia; also Professor Antero Vaarama, University of Turku, Finland; Dr. H. B. S. Womersley and Miss E. S. Wollaston of the University of Adelaide, Australia; Dr. P. A. Munz of the Rancho Santa Ana Botanic Garden; and Professor W. R. Philipson, University of Canterbury, New Zealand.

Field studies were carried out in Hawaii this summer by Dr. Richard White, Mr. William Anderson and Mr. Marshall Crosby, all working from the Department of Botany at Duke University. Mr. Anderson completed field work on the genus Elaphoglossum (Aspidiaceae) in Hawaii.

Dr. Charles H. Lamoureux is directing a field study of the vascular plants of the low islands of the Central Pacific under the auspices of the Smithsonian Institution. Mr. Charles Long and Mr. Alan Young are field collectors for this project.

DEPARTMENT OF HORTICULTURE: Dr. Richard A. Hamilton will spend sabbatical leave in Costa Rica. Dr. Yoneo Sagawa, specialist in cytogenetics and meristem tissue culture of orchids is a new staff member in the department. Dr. Sagawa was formerly in the Department of Botany at the University of Florida, Gainsville. Dr. Yozo Iwanami has taken a post-doctoral appointment in the laboratory of Dr. Brewbaker. Dr. Iwanami comes from Yokohama Municipal University.

Drs. James Lockhart, Robert Warner and James Brewbaker presented papers at the recent A.I.B.S. meetings at Boulder, Colorado. Others from Hawaii who were in attendance at the meetings included Dr. Jimmie B. Smith, Dr. Bruce Rogers and Dr. George Gillett. Hawaii representatives at the International Botanical Congress, Edinburgh, included Professor Maxwell S. Doty and Dr. Dieter Mueller-Dombois, both of the Department of Botany, and Drs. Beatrice Krauss and Wallace Sanford of the Pineapple Research Institute.

Recent promotions at the University of Hawaii include: Dr. James Brewbaker from Associate Horticulturist to Horticulturist, Dr. Richard Hine from Assistant to Associate Plant Pathologist, Dr. Henry Nakasone from Assistant to Associate Horticulturist, and Mr. Warren Yee from Assistant Specialist to Associate Specialist in Horticulture.

DEPARTMENT OF GENETICS: Dr. Jimmie Bob Smith has accepted the position of Head, Variety Improvement Section, Pineapple Research Institute. Dr. Smith was formerly with the Department of Genetics at the University of Hawaii.

B O T A N I C A L N O T E S

PACIFIC TROPICAL BOTANICAL GARDEN: On August 20, 1964, President Johnson signed into law Senate Bill 1991 as amended. This Bill charters, by Act of Congress, the Pacific Tropical Botanical Garden. The Hawaiian Botanical Society has long supported this Bill and is a sponsor member of the Hawaiian Botanical Gardens Foundation, the organization which led the fight for its passage. Senate Bill 1991 was introduced by Senators Daniel Inouye and Hiram Fong who worked diligently for its passage, as did Representative Spark Matsunaga, who had introduced an identical bill in the House and was instrumental in obtaining House approval of the Senate Bill. Special recognition and gratitude are extended to Mr. W. W. G. Moir, President of the Foundation, who carefully executed the groundwork necessary to secure passage of the Bill.

The Bill creates a corporation, the Pacific Tropical Botanical Garden, authorized to "establish, develop, operate, and maintain. . . . an educational and scientific center in the form of a tropical botanical garden or gardens." The first meeting of the Board of Trustees was held in Washington late in October, at which Mrs. A. Lester Marks and Mr. W. W. G. Moir were elected to the Board.

On October 31 Professors G. Ledyard Stebbins and A. J. Sharp, past and current presidents of the Botanical Society of America, respectively, examined possible sites for the Pacific Tropical Botanic Garden, accompanied by Professor A. C. Smith, University of Hawaii, and Mr. W. W. G. Moir.

ALLERTON MAKES GIFT TO PACIFIC TROPICAL BOTANICAL GARDEN: Mr. Robert Allerton of Lawai, Kauai, has made a gift of $1,000,000 to the Pacific Tropical Botanical Garden. Mr. Allerton has long been interested in the development of this garden and made significant contributions to the Hawaiian Botanical Gardens Foundation which enabled the Foundation to work for passage of the Bill. He is a member of the Board of Trustees of the Pacific Tropical Botanical Garden. The Society extends its deepest appreciation to Mr. Allerton for his generous and timely support of the Garden.

FOSTER GARDEN: On June 1, 1964, the deed to Parcel C-5, Queen Emma Project, was presented to Mayor Blaisdell by the Honolulu Redevelopment Agency. This two-acre parcel at Nuuanu and Vineyard will be added to Foster Botanical Garden. The Hawaiian Botanical Society was active in the long struggle which has ended favorably.

OSCAR KIRSCH HONORED: On April 27 Mr. Oscar Kirsch, past Vice-President and current Director of the Society, received another international award for his outstanding orchids. He was presented a gold medallion and certificate from the International Garden Show of Hamburg, Germany. The award was for orchid sprays entered by Mr. Kirsch in the Hamburg show held in October, 1963. The award was presented by the Honorary German Consul in Honolulu, Mr. Herbert M. Richards.

DEMONSTRATION PLANTS

A most enjoyable high-light of each meeting is the presentation of outstanding orchids thoughtfully exhibited by Mr. Oscar Kirsch. All members are grateful to Mr. Kirsch for sharing his outstanding materials with us. It is hoped that additional members might complement Mr. Kirsch's orchids with interesting and unusual plants from their research or ornamental collections. Your contributions are anticipated with enthusiasm.

DUES

Members who are delinquent for 1964 dues are urged to make prompt payment to the treasurer, Mr. William M. Bush, Castle and Cooke, Inc., Box 2990, Honolulu 2, Hawaii. The 1964 dues are $2.00.

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THE HAWAIIAN BOTANICAL SOCIETY was founded in 1924 to "advance the science of Botany in all its applications, encourage research in Botany in all its phases," and "promote the welfare of its members and to develop the spirit of good fellowship and cooperation among them." "Any person interested in the plant life of the Hawaiian Islands is eligible for membership in this Society."

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The Hawaiian Botanical Society Newsletter is published in February, April, June, October, and December. It is distributed to all Society members and other interested individuals and institutions, with the purpose of informing them about botanical news and progress in Hawaii and the Pacific. News contributions and articles are welcomed. The deadline for submission of news items is the 20th of each month prior to publication.

Produced at the University of Hawaii and at the Experiment Station, HSPA.
Membership dues are $2.00 per calendar year and include receipt of the Newsletter.

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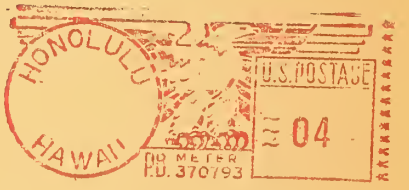

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